OMB Approval No. 2700-0087

National Aeronautics and Space Administration
Office of Biological and Physical Research
Washington, DC 20546

Research Announcement

Research Opportunities
for
Ground-Based Research
in
Space Radiation Biology
and
Space Radiation Shielding Materials

NRA 03-OBPR-07
October 10, 2003

NASA Research Announcement Soliciting Research Proposals for the Period Ending January 9, 2004

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Summary and Supplemental Information

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals for ground-based research in space radiation biology and space radiation shielding materials. NASA will provide beams of high-energy heavy nuclei produced at the NASA Space Radiation Laboratory (NSRL) and the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory (BNL) for this research. These beams simulate the high-energy, high-charge (HZE) components of galactic cosmic rays that constitute the biologically most significant component of space radiation. NSRL is a new $34 million irradiation facility at BNL, funded by NASA, completed in June 2003.

This research supports NASA's mission and the Office of Biological and Physical Research (OBPR). All participants in this NRA are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the physical sciences, the space environment, and the OBPR programs through formal and informal education opportunities. Where appropriate, supported investigators will be required to produce, in collaboration with NASA, a plan for communicating their work to the public.

Proposals for this NRA must be received by 4:30 p.m. Eastern time on January 9, 2004. Proposals shall not be submitted electronically, except the cover page as specified in this NRA. Proposals and notices of intent must be sent to the following address:

NASA Peer Review Services
SUBJECT: 03-OBPR-07 Space Radiation Research Proposal
500 E Street SW
Suite 200
Washington, DC 20024

Proposals and notices of intent must be delivered to the above address between 8:00 a.m. and 4:30 p.m. The telephone number (202) 479-9030 may be used when required for reference by delivery services. NASA Peer Review Services (NPRS) cannot receive deliveries on Saturdays, Sundays, or federal holidays. NPRS will send notification to the investigator confirming proposal receipt within 5 business days of the proposal receipt date; however, there will not be a response from the Office of Biological and Physical Research.

The following items apply only to this Announcement:

Solicitation Announcement Identifier:	NRA 03-OBPR-07
Number of Copies Required:	Original + 20 copies
Notices of Intent Due:	November 10, 2003
Proposals Due:	January 9, 2004
Estimated Selection Announcement:	April 2004
Office of Biological and Physical Research Selecting Officials:	Directors, Bioastronautics Research Division Fundamental Space Biology Division Physical Sciences Research Division

Safety is NASA's highest priority. Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect: (1) the public, (2) astronauts and pilots, (3) the NASA workforce (including employees on NASA-sponsored projects), and (4) high-value equipment and property. All research conducted under NASA auspices shall conform to this philosophy.

In this NRA:

- Appendix A provides a detailed description of the research areas being solicited.
- Appendix B contains specific application instructions and review process information.
- Appendix C contains copies of the certifications required with any signed application.
- Appendix D contains general information on submitting to NASA research announcements and is supplemental to the instructions contained in Appendix B.
- Appendix E contains required forms

Proposals submitted in response to this Announcement must address the research emphases defined in this Announcement. Those proposals that do not will be returned to the investigators. **This Research Announcement does not solicit spaceflight research.** Other Announcements calling for focused research or utilization of unique resources may be issued throughout the year. Unsolicited proposals received at other times during the year will be held until the next annual review period if the proposed research is relevant to the programs described in this Announcement. However, NASA reserves the right to act in the best interest of the federal government in the matter of proposal acceptance and evaluation.

Proposals for research must be unique and must not duplicate work already being funded by NASA. Proposers are encouraged to consult the NASA Task Book for a compendium of work already being performed in each research area. The FY 2002 Task Book is available at the following Web site: http://research.hq.nasa.gov/taskbook.cfm. A list of research projects selected in FY 2003 for funding can be found at: http://www.nasa.gov/news/research/awardees.html.

Proposals will be funded in one-year increments for activities lasting up to **four** years. The funding duration will depend on proposal requirements, review panel recommendations, and demonstrable progress of the activity. All proposals will be evaluated for overall scientific and technical merit by independent peer review panels. NASA will evaluate relevance to programmatic needs and goals separately. The government's obligation to make awards is contingent upon the availability of appropriated funds from which award payments can be made, and the receipt of proposals that the government determines are acceptable for award under this NRA. Depending on available funding and the results of peer review for scientific merit, approximately 20 investigations may be selected. It is anticipated that a typical Bioastronautics award will average **$200,000** per year (total cost), a typical Fundamental Space Biology award will average **$200,000** per year (total cost), and a typical Physical Sciences award will average **$150,000** per year (total cost). NASA reserves the right to return proposals, without review, that exceed the described award amounts or that are in NASA's judgment not compliant with the other requirements stated in this NRA. NASA does not provide separate funding for direct and indirect costs; the amount of the award requested is the total of all costs submitted in the proposed budget. It is estimated that selections will be announced by **April 2004** and grants or contracts awarded shortly thereafter.

Participation in this Announcement is open to all categories of organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other government agencies. Guidelines for International Participation are detailed in Appendix D, section L of this announcement.

A notice of intent to propose is requested by **November 10, 2003** (see Instructions, Appendix B of this Announcement). Notices of intent should be submitted via the World Wide Web (WWW) at:

http://proposals.hq.nasa.gov/proposal.cfm

If you do not have access to the WWW, you may submit a notice of intent by U.S. Postal Service or commercial delivery to the following address:.

NASA Peer Review Services
SUBJECT: 03-OBPR-07 Space Radiation Research
500 E Street SW
Suite 200
Washington, DC 20024
(202) 479-9030

In order to be accepted as a complete submission, proposals must include all information requested in Appendix B. Additional technical information is available from:

David L. Tomko, Ph.D.
NASA Headquarters, Code UB
Washington, DC 20546-0001
Telephone: (202) 358-2211
Fax: (202) 358-4168
E-mail: dtomko@nasa.gov

Additional contractual information is available from:

NASA Office Of Procurement
Code HS
NASA Headquarters
Washington DC 20546-0001
Telephone: (202) 358-0445

The specific contracting point of contact will be specified in each selection notification letter.

This Announcement is restricted to the program named above and described in detail in Appendix A. Potential investigators should read with care the program descriptions that are of interest and focus their proposals on the specific research emphases defined in this Announcement.

Your interest and cooperation in participating in this effort is appreciated.

Original signed by

Mary E. Kicza
Associate Administrator
Office of Biological and Physical Research

APPENDIX A
NRA 03-OBPR-07

Scientific/Technical Description
Ground-Based Research in Space Radiation Biology and Space Radiation Shielding Materials

I. Introduction

The major goal of NASA's Space Radiation Research Program within the Office of Biological and Physical Research is to enable human exploration of space without exceeding limits on risks from space radiation. Space radiation is distinct from terrestrial forms of radiation, being comprised of high-energy protons and heavy ions and their secondaries produced in shielding and tissue. Because there are no human epidemiological data for these radiation types, risk estimation must be derived from mechanistic understanding based on radiation physics, and on molecular, cellular, and tissue radiation biology related to cancer and other risks of concern to NASA. Research to be supported will seek to reduce the uncertainties in risk predictions, including cancer, degenerative tissue damage (e.g., the central nervous system (CNS) and cataracts), hereditary risks, and acute risks, and lead to the development of effective shielding or biological countermeasures to these risks.

This Appendix defines the research program and elements encompassed by this Announcement, describes the specific areas of ground-based research that proposals should address, and describes the specific emphases that are acceptable for submission in response to this Announcement. **This NRA does not request proposals for spaceflight research.** It is important that the prospective investigator read the relevant section(s) carefully, as some of the programmatic emphases are different from those appearing in previous Division Announcements. In addition, this NRA includes guidelines for preparing and submitting proposals and defines the administrative policies governing the program and investigators.

II. Research Areas of Interest

Research proposals are expected to utilize beams of charged particles available at Brookhaven National Laboratory (BNL), the Galactic Cosmic Ray (GCR) environment available to Radiation Shielding investigators on the Deep Space Test Bed (DSTB), or to address experimental data obtained with such beams in ways leading to significant predictions that can be tested in future experiments. In FY2004, the beams most likely to be available are those from the NASA Space Radiation Laboratory (NSRL). Alternate Gradient Synchrotron (AGS) beams are available, but scientific justification for the use of their higher energies will need to be provided. NASA intends to operate these facilities for 1200 hours per

year if funds are available; selection of beam species and beam energies for experimental running periods will be made by program managers in consultation with scientists proposing experiments for these beams. Investigators selected for funding will need to meet BNL requirements for experiment scheduling in order to gain access to beams and irradiation facilities. Proposals for utilization of the DSTB prior to January 2006 cannot be supported. Researchers are encouraged to consult Section V, Facilities, for a more detailed description of the test opportunities afforded by the DSTB.

NASA negotiates beam delivery directly with BNL, and investigators proposing to use the BNL irradiation facilities should not include the cost of beam time in their budgets. However, investigators should include the cost of carrying out the experiments, including travel to these facilities, and provide an estimate of the hours of beam time. Investigators wishing to utilize other facilities must provide a detailed justification for their use and must include certification that use of those facilities will be at no cost to NASA.

Bioastronautics Research

This area is concerned with the application of mechanistic understanding to mammalian models to achieve significant reductions in the uncertainties in risk projections for cancer, degenerative tissue effects including damage to the CNS, and other health effects caused by space radiation or to develop effective biological countermeasures to these risks. Biological effects of importance include DNA damage processing, signal transduction, cell cycle controls, cellular differentiation, bystander effects, genomic instability, genetic sensitivity or resistance, signal transduction, and persistent oxidative damage. The solicited research will develop approaches to understand the effects of protons and heavy ions as modifiers of these processes. The use of such understanding to develop new transgenic mouse or tissue models improving our ability to extrapolate estimates of cancer and other risks to humans is of high priority. Finally, the development of methods for accurate, quantitative risk prediction is encouraged, both experimentally in terms of biological predictors of individual radiation risk and theoretically using appropriate models for quantitative individual risk assessments.

Fundamental Biology

This area is concerned with basic understanding of the effects of the space radiation environment on fundamental biological processes. These include: DNA structural and functional changes caused by radiation, such as mutations and DNA recombination and repair; basic metabolic controls important in biology and known to be modulated by radiation; the cell cycle, especially in relation to cellular repair mechanisms and programmed cell death; mechanisms of tissue and organ response to radiation including signal transduction; and “bystander” effects and genomic instability. The knowledge gained should have plausible links to Bioastronautics studies directed at estimating risk to astronaut health and ameliorating negative health effects of space flight. To an appropriate extent, these studies should also lead to quantitative predictions about the

interaction of hypergravity or simulated microgravity on these mechanisms that can be subjected to experimental validation.

Physical Sciences Research

This area emphasizes studies of the basic, as well as applied, physical aspects of the interaction of high energy charged (HZE) particles with matter, and the design, fabrication, and testing of multifunctional radiation shielding materials. Experimental data are available from the work of ongoing NASA-supported measurements of nuclear interaction cross sections and yields via the FY03 selected Cross Section Measurements Consortium, and complementary radiation transport codes are being developed by NASA-supported investigators via the FY03 selected Radiation Transport Codes Consortium. The compilation of data into easily accessible formats and the development of three-dimensional standardized radiation transport codes for use by designers of mission architectures are priorities for the consortia. There are multiple transport code and cross section measurement methodologies currently being pursued by the consortia and NASA has assigned a lower strategic value to new proposals in these areas. However, novel research concepts that significantly accelerate NASA's development of an accurate modeling tool of the radiation transport phenomenon are solicited. NASA encourages researchers to utilize the facilities and capabilities of these previously selected consortia. Researchers needing cross-section/yield measurements or radiation transport calculations should contact the appropriate consortium. Consortium points of contact are listed in Section VI, "Other Technical Information."

Those proposing in response to this NRA are encouraged to take advantage of the services afforded by the Space Radiation Shielding Program (SRSP) at Marshall Space Flight Center (MSFC). Please reference http://www.radiationshielding.nasa.gov/ for additional information.

III. Research Elements and Emphases

A. Background Information

The following background information is intended to serve as an introduction to concepts essential for an understanding of space radiation research for scientists working in rapidly developing areas of life sciences or materials sciences not necessarily associated with the study of radiation. It is also intended to serve as an overview to scientists familiar with the use of conventional sources of terrestrial radiation who are interested in extending cutting edge radiation-related research to the problems of space radiation. Further details may be found in the list of references. NASA scientists are available to assist investigators wishing to enter this field of research and all investigators considering a response to this solicitation are encouraged to request more information. Experienced space radiation investigators may wish to skip this section.

The components of space radiation of greatest biological significance are the highly-charged, energetic heavy ions, also known as HZE particles, present in Galactic Cosmic Rays (GCR). The biological effects of radiation are a consequence of chemical reactions initiated by energy deposition in cells and tissues. These reactions modify the division processes by which cells reproduce as well as other cell functions required for healthy living organisms. Cells have the ability to repair themselves; when that repair is successful, the tissues and organisms return to their normal state. When the repair is not successful, cells may die. If a sufficiently large number of cells are killed, tissue integrity and function may be impaired, as occurs in acute radiation effects. Repair may be successful from the point of view of cell survival, but may contain latent errors that only manifest in subsequent generations of dividing cells. These errors may also alter the sensitivity of cells to further insults. Eventually radiation damage, in conjunction with other stresses, may further alter the cells or their interaction with surrounding tissues, as is assumed to occur during the induction of cancer, leading to delayed health effects.

For the particles composing space radiation, energy deposition is highly localized along the trajectory of each particle. This high rate of energy deposition per unit length of trajectory is the Linear Energy Transfer or LET; the unit generally used in radiobiology is the kilo-electron volt per micrometer, or keV/μm. The LET of charged particles changes as a function of the particle velocity or kinetic energy. As the velocity (or the energy) of a particle increases, the LET decreases to a minimum near a velocity of approximately 95% of the speed of light; at higher energies the LET increases very slowly. High-energy charged particles lose energy when they traverse any material. As they slow down, the LET increases to a maximum and then very rapidly decreases to zero. The low-energy maximum in LET occurs very close to the point where the charged particle loses its remaining energy and stops.

GCR particles of average energy can penetrate a substantial thickness of materials, on the order of several inches of aluminum. If they suffer nuclear interactions, the lighter secondary products will lose energy at a lower rate, and therefore will be able to penetrate even further. For this reason, it is not possible to provide sufficient material to fully absorb all types of radiation in space. In addition, the biological effectiveness of radiation will change as a function of depth of penetration, because the composition of the particles changes and because the LET of each particle changes as it loses energy and slows down inside the material.

Historically, the majority of radiobiological studies have been conducted using x-rays, which have become the standard of comparison and have a very low LET. Higher-LET particles generally require a lower dose than x-rays to induce a given observable biological effect. The quantity used to describe this is the relative biological effectiveness (RBE), which is equal to the ratio of the (generally higher) x-ray dose to the (generally lower) particle dose resulting in the same endpoint. For a multitude of radiation endpoints, the RBE varies significantly as a function of LET. The RBE peaks in the neighborhood of approximately 100 keV/μm, reflecting the geometry of sensitive targets within the cell. However, above this peak, the effectiveness for most endpoints again decreases, due to the fact that further energy deposition in the damaged sites is wasted once a particular endpoint has been achieved.

The characterization of radiation quality in terms of RBE is widely used to describe biological response to radiation, and is also the basis for the regulatory approach that specifies Quality Factors patterned after the LET dependence of RBE. Nevertheless, it is limited to biological endpoints for which a significant response to x-rays can be obtained. When this is not the case, the ensuing very large values of RBE ("infinite RBE") may be due to the lack of efficacy of x-rays rather than a particularly effective aspect of the high-LET radiation. The mechanisms and biological effects associated high-LET radiation also may be different from those attributable to x-rays for the same, or similar, macroscopic endpoints. For that reason, the description of radiation action is not complete without an understanding of the processes leading to an observed result.

At the present time, protection against the deleterious health effects of radiation is mainly achieved by limiting access to high radiation environments, controlling the duration of radiation exposure, and by using materials to absorb radiation or degrade its energy. Materials with the smallest mean atomic mass are usually the most efficient shields for the GCR. Except for physical properties and safety considerations, hydrogen would be the best shield. The reasons for this are not immediately apparent, because the absorbed dose from space radiation is delivered by many different kinds of particles, incident on structures in space at a wide range of incident energies. The composition of the radiation field changes as particles lose energy and suffer nuclear interactions while traversing structural materials, instruments, and the bodies of crewmembers. Both the energy loss and the changes in particle fluence are related to the number of atoms per unit mass (in units such as grams) in the traversed material, which, in turn, is proportional to Avogadro's number divided by the atomic mass, A, for each element of the material.

The energy loss by ionization of a single component of shielding material with atomic number Z is proportional to the number of electrons per atom and thus proportional to Z. However, the energy lost per gram of material and per incident fluence (e.g., in units of particles per cm^2), the "mass stopping power," is also inversely proportional to the density, ḍ (e.g., in g/cm^3) of the material, so that the energy lost by one incident particle per cm^2 per unit mass is proportional to Z/dA.

The number of nuclear interactions per unit mass and per unit incident fluence is proportional to σ/A, where σ is the total nuclear reaction cross section. To a first approximation, σ is proportional to $A^{2/3}$, so that the nuclear transmission is proportional to $1/A^{1/3}$. The ratio of electronic stopping power to nuclear interaction transmission is thus proportional to $Z/dA^{2/3}$.

Materials with small atomic mass have the highest number of electrons per nucleon (e.g., Z/A is 1 for hydrogen, 0.5 for carbon, but 0.48 for aluminum, 0.46 for iron, and 0.40 for lead). However, light mass materials have smaller nuclei and therefore more of them can fit into a given mass, so that there can be more nuclear interactions. Furthermore, the ratio of ionization energy loss to nuclear interactions is also dependent on the material density. For liquid hydrogen (d=0.07 g/cm^3), the ratio is ~14, whereas for aluminum (d=2.7 g/cm^3) the ratio is only 0.5, and for lead (d=11.3 g/cm^3) the ratio is 0.2.

It is clear from these considerations that a hypothetical shield consisting only of electrons, and thick enough to ensure that a particle loses all its energy inside it (a thickness referred to as the "range" of the particle), would provide ideal shielding characteristics. A close second choice would be a hypothetical shield made of hydrogen, which has the highest ratio of electrons to nuclei per atom. However, while the range of an energetic iron nucleus with an energy of 1 GeV/nucleon (near the peak of the GCR energy spectrum) is approximately 30 cm in water (approximately 10 cm in aluminum), the range of a proton is 12 times greater and a shield intended to stop all particles up to iron would have to be equivalent to 300 cm of water or 100 cm of aluminum. Such thickness is not practical, and nuclear reactions will always be a component of shielded radiation fields.

Slowing down incident GCR particles using materials with a preponderance of energy loss due to ionization and a minimum probability of nuclear interactions is not always an optimal strategy. Nuclei such as carbon and oxygen, incident at high energy, have low LET, well beneath the peak value of RBE. When they lose energy in a shielding material (without suffering nuclear interactions), their LET increases. As a consequence, their RBE also increases instead of decreasing, so that they become more hazardous, rather than less hazardous. On the other hand, the LET of incident, high-energy heavier nuclei, such as iron, is close to the 100 keV/μm corresponding to the peak RBE. Losing energy and slowing down further increases their LET beyond the peak, yet they become no more hazardous despite their higher LET.

Conversely, nuclear interactions that change a penetrating GCR nucleus into lighter nuclei, e.g., nuclear interactions that fragment silicon into carbon and helium-4 (alpha particles), result in particles of lower RBE, the desired outcome. On the other hand, the fragmentation of high-LET iron into lower-LET chromium or silicon fragments would change the contribution to the radiation field from less hazardous particles, beyond the RBE peak, to more hazardous particles with an LET at or before the peak.

The character of these interactions is also important. Lighter nuclei have fewer neutrons to release and some nuclei, e.g., carbon, can break into three helium nuclei without releasing any neutrons. For very thick shields, lighter nuclei are also more effective in shielding against the built up neutrons. For these and related reasons, detailed knowledge of the actual composition of the radiation fields (and of the biological consequences of exposure to them) is required to evaluate the net effect of shielding materials.

B. Critical Path Roadmap

Research to be supported will seek to reduce the uncertainties in risk predictions, including cancer, degenerative tissue damage (e.g., the central nervous system (CNS) and cataracts), hereditary risks, and acute risks, and lead to the development of effective shielding or biological countermeasures to these risks.

In order to identify and make publicly known the biomedical risks of space flight, and the research questions that must be answered to reduce those risks, NASA has developed the Critical Path Roadmap (CPR). Proposals addressing issues of relevance to the radiation areas of interest must represent questions and priorities enumerated in the CPR. The CPR is an interdisciplinary tool to assess, understand, mitigate, and manage the risks to humans that are associated with long-term exposure to the space environment. It assumes an overarching strategy that integrates requirements, risks, risk factors, critical questions, tasks, deliverables, and risk mitigation with the intent of directing biomedical research in support of human space flight, especially human missions of exploration. The CPR is based in part on analysis by NASA scientists, NSBRI scientists, advisory committees representing the United States science community, task forces, and published reports such as the National Research Council (NRC) Space Studies Board's "A Strategy for Research in Space Biology and Medicine in the New Century;" the Aerospace Medical Advisory Committee; the NASA Task Force on Countermeasures; the International Space Life Sciences Working Groups publications on Radiation, Bone, Muscle, Cardiovascular, Human Factors, and Neuroscience Workshops; and the NASA Medical Policy Board Document.

The ultimate goal of the CPR is to better define and focus the research that is required to protect the health and safety of space flight crews for development and validation of operational health care "deliverables" for the prevention, treatment, and rehabilitation of space flight changes and of appropriate habitation and medical care systems.

Potential investigators should be review the Critical Path Roadmap in its entirety at http://criticalpath.jsc.nasa.gov/. **The proposer must examine and understand the CPR, and specify in their proposal the rationale and evidence underlying which risks and critical questions their proposed research will answer by completing the form found in Appendix E**.. NASA will perform a similar assessment to understand how the proposed research addresses the CPR risks and critical questions. Proposals that do not identify which CPR risks and questions are being addressed by the research will be returned to the proposer without review.

There are currently five categories of radiation risks in the Critical Path Roadmap:

- Carcinogenesis
- Degenerative tissue diseases including damage to the central nervous system, cataracts, circulatory diseases, or other late non-cancer risks
- Early radiation syndromes
- Radiation and sterility, fertility, or hereditary risks
- Synergistic risks from the combined effects of radiation, microgravity, and other spacecraft environmental factors.

Each radiation risk has an associated set of core questions. The current Critical Questions in radiation are:

- Are there unique biological effects associated with high charge and energy (HZE) ions?
- What is the acceptable accuracy for risks of acute and late effects in humans from photons to adequately extrapolate to space?
- How can animal and cell experiments be done and data best be used to extrapolate to the human risk from space radiation?
- What are the risks from SPEs and what is their impact on operations, space-walks and surface exploration?
- How do the thickness, design, and material composition of space vehicles affect the internal radiation environment and biological assessment?
- Do we have strategies for calculating risks that are adequate if expected data are provided and what are uncertainties?
- Are there differences in response to particles with similar LET, but with different atomic numbers and energies?
- What are the effects of age, gender, and inter-individual diversity?
- Are the biological effects for protons above 10 MeV sufficiently similar to photons that photon data can be used for their consequences?
- Are there chemo-preventive or biological agents that would mitigate acute or late effects?

C. Description of Research Elements

Studies may include animals (including humans), plants, tissues, or cells. Researchers should use the species most appropriate for their research and are encouraged to take advantage of functionally characterized transgenic and mutant species as well as comparative biology approaches that enhance the research scope. Note that as part of the proposal submission process assurance of compliance with applicable federal regulations regarding human subjects or animal care and use is required (see the "Special Matters" instructions in Appendix B).

Investigators are encouraged to review summaries of the research currently funded in this program by accessing the NASA Office of Biological and Physical Research (OBPR) Tasks and Bibliography (OBPR Task Book) at http://research.hq.nasa.gov/taskbook.cfm.

To be responsive to this research solicitation, proposed studies should be hypothesis-driven and lead to new knowledge within accepted scientific standards. Purely phenomenological approaches with no significant mechanistic basis or likely gain in scientific knowledge are not acceptable.

Proposals are required to provide evidence for expertise in radiation, either by reference to the Principal Investigator's work or by the inclusion of active collaborators expert in radiation research.

Proposals should take into account the impact of gender, age, nutrition, stress, genetic predisposition, or sensitivity to other factors of importance in managing space radiation risks.

D. Research Emphases for FY 2004

The following are high-priority research topics for FY2004:

1. **Molecular Radiation Biology of Carcinogenesis**: Improving estimates of cancer risks from space radiation using genetic- and molecular-based animal or tissue models, and developing the knowledge needed to use such models to project risks in humans are priority research areas. This research component will seek to understand the molecular mechanisms of carcinogenesis by protons and HZE particles, including the understanding of genomic instability and the development of new experimental models of radiation-induced cancers. Research involving the measurement of tumor induction by radiation without a mechanistic hypothesis is not being considered at this time.

2. **CNS Radiobiology:** This topic addresses the understanding needed to estimate the risk to the central nervous system (CNS), especially the short-term and long-term degenerative risks from low doses (<0.3 Gy) of HZE particles, and proton doses from solar particle events (0.1 to 3 Gy). General questions to be answered include the following: Are the deleterious effects that are observed in cancer patients receiving high dose irradiation to the CNS observed when rodents are irradiated by HZE particles? What are the cellular and molecular mechanisms of damage to the CNS following irradiation by HZE particles? What morphological changes occur?

3. **Models of Non-Cancer or Degenerative Tissue Risks:** Recent epidemiology studies have identified a significant non-cancer/non-CNS risk in cohorts exposed to low-LET radiation. These risks include increased morbidity and mortality due to circulatory and heart diseases. This topic addresses the identification of the mechanisms of these risks and the development of experimental models to estimate the risk from protons and HZE ions, including the basis for describing dose, dose-rate and latency dependencies.

4. **Individual Susceptibility:** This topic addresses individual-based approaches to risk projections, including the understanding of genetic or epigenetic factors that contribute to sensitivity or resistance to radiation, and the development of molecular markers of cancer, CNS, or cataract risks that will allow NASA to project the individual's risk to space radiation.

5. **Discovery of Biological Countermeasure:** This topic addresses the development of the molecular understanding and identification of targets for risk assay development and intervention leading to the discovery of successful countermeasures from space radiation. Translational research that incorporates mechanistic knowledge of cancer, CNS, or cataract risks as a basis for countermeasure development is highly desired.

6. **Cellular and Molecular Biology:** Proposals to study HZE radiation- induced lesions at the molecular and cellular level are desired. Of interest are studies to determine the nature of the lesions induced (both immediate and persistent), the mechanisms by which the lesions are formed, and the potential consequences of the induced damage to cellular processes. Also of great interest are studies of damage identification, processing, and repair; and compensatory mechanisms such as induction of apoptosis, stem cell recruitment and differentiation, and tissue remodeling and repopulation. Examples include studies of the repair of DNA single- and double-strand breaks, mis-match repair, and recombination. Potential targets include, but are not limited to: DNA and the replicative and transcriptional complexes, cellular membranes including the mitochondria, the cellular cytoskeleton and proteins involved in attachment and motility, RNA and the translational machinery of the cell, protein expression and processing, and signal transduction. Studies are encouraged in a wide range of cell types including mammalian, insect, and nematode; and cells of different origin, including somatic cells from various tissue types and germ line cells. Of particular interest are studies of mammalian immune, neurological, gastrointestinal, bone, and muscle cells.

7. **Novel Shielding and Multi-Functional Materials:** Polyethylene (PE), due to its high hydrogen content relative to its weight, has been shown to be an effective shielding material against galactic cosmic rays and solar energetic particles. This NRA solicits proposals that address the design, fabrication, and testing (including accelerator-based testing) of novel shielding materials that can be shown (i.e., via measured or simulated radiation transport properties) to approach or improve upon PE's performance. In addition, this NRA solicits proposals to address in detail the intended in-situ multi-functionality of said materials, whether as primary structural/shielding or secondary shielding materials (e.g., shielding associated with non-primary structural components of the space vehicle). Proposals addressing questions associated with the cost, processing, efficiency, safety, etc.

associated with the manufacturing of known or potential shielding materials are also sought by this NRA. Finally, proposals written to specifically address more basic questions pertaining to the radiation transport properties of known or potential shielding materials, e.g., development of simulation and transport methodologies/codes, calculation/measurement of nuclear cross sections, etc., while selectively (see Section II) sought are deemed to be of less strategic value by this NRA.

IV. Ground Facilities Description

A. Ground-Based Radiation Accelerator Facilities

NASA has signed agreements with Loma Linda University (LLU) Medical Center related to the use of proton beams, and with Brookhaven National Laboratory (BNL) for the use of heavy ion beams at the Alternating Gradient Synchrotron (AGS). **This NRA solicits proposals for research at BNL**; information about LLU is provided because proton irradiations have constituted an important component of the broader research program, and investigators may have reason to seek access to proton beams for preliminary results or comparison with existing data. Delivery of beam time at BNL is directly funded by a contract between NASA and Brookhaven. Use of the Brookhaven facilities requires a separate proposal, which is reviewed by a laboratory-appointed panel and is scheduled in accordance with available beam time and other laboratory resources. Once experiments are approved, they are required to satisfy the normal process of preparation, which includes familiarization with rules and policies (safety being the paramount consideration among these) and registration with the laboratory as a guest scientist.

A new facility at BNL, the NASA Space Radiation Laboratory (NSRL), became operational in June 2003. The NSRL is an accelerator facility that provides ions from protons to gold in the energy range of 40-3000 mev/nucleon, using beams from the AGS Booster synchrotron placed between the Van de Graaff injectors and the higher energy AGS. The NSRL is a joint effort of the collider-accelerator department, providing accelerated ion beams; the BNL Biology department, providing experimental area support; and the Medical department, which provides animal care facilities and cell laboratories. The experimental facilities consist of a well-shielded irradiation area and a support building containing ready-rooms, laboratories, and offices. Other existing on-site facilities, such as the Medical Department's extensive animal handling installations, may also be utilized. Dosimetry and local access control will be provided through a local facility control room.

The Brookhaven AGS Booster is an ideal source for the NSRL due to the good overlap between the available ion masses and energies with those encountered in space. A variety of high-Z-energy (HZE) particles are available with energies ranging from a maximum of 1.3 GeV/amu for the lightest ions, to approximately 1.1 GeV/amu for iron, and approximately 300 MeV/amu for gold, to a minimum of less than 100 MeV/amu. Beams of 290 MeV/A carbon, 1200 MeV/A

titanium, and 1000 MeV/A iron have been accelerated. Heavy ions originate in the Brookhaven MP-6 tandem accelerator and are transported to the Booster synchrotron for acceleration to the required energies. Concurrent operation of the Booster for space radiation research and other kinds of research applications is achieved by utilizing independent tandem injectors. At the Booster a new slow-extraction system has been implemented and a new beam line and tunnel enclosure have been built to transport the extracted beam to the experimental facility. Uniform beam intensities have been measured over rectangular areas ranging in size from about 1 cm to about 20 cm with uniformity of ±5%.

The AGS machine at BNL is a U.S. Department of Energy (DOE) facility that is funded by the DOE primarily for research in high-energy particle and nuclear physics. Brookhaven is allowed by the DOE to provide additional AGS beam time to other scientific users of the machine, as long as the sponsor of such proposed work provides operating funds. A 10-ft long optical bench for sample exposures is available in the cave, as well as beam handling, sample changing, and dosimetry instrumentation. The biological experiment station contains one area for cell culture equipped with a laminar flow hood and incubator, one short-term animal holding facility, and one area for physics/run-control use. Iron (^{56}Fe) beams at 600 MeV/nucleon and at 1 GeV/nucleon, as well as ^{28}Si and ^{79}Au, have been used for experiments to date; investigators who need to use other beams or energies should contact the Brookhaven liaison scientists listed below. Normally, circular beam spots are provided, with diameters up to 10 cm and center-to-edge uniformity between 10% and 20% (depending on dose rate—high dose rate beams are less uniform than low-dose rate beams). Dose rates have been measured up to 11 Gy/min. Investigators currently funded by the NASA program participate in research using these beams, and coordination of beam use with these investigators and institutions is actively encouraged. In particular, a physics and dosimetry group is available for investigators requiring their assistance.

User facilities have been developed at Brookhaven for radiation biology research, including cell cultures and small animals. These include the shielding caves containing the beam and the experiment station. In addition, laboratory space and access to animal facilities accredited by the Association for Assessment and Accreditation of Laboratory Animal Care are available in the Medical Department, subject to standard use charges. Brookhaven also has on-site housing accommodation for users (dormitory and apartment-style units).

NASA will assist investigators in planning and conducting materials experiments at the NASA Space Radiation Laboratory (NSRL). Proposals that include utilization of the NSRL should include a list of desired ions and energies, and the estimated beam time. It is anticipated that there will be several opportunities each calendar year for investigator beam time. However, beam times are subject to change and contingent upon availability of funding.

Further detailed information on BNL is available at: http://www.bnl.gov/bnlweb/userindex.html. For further information regarding Brookhaven National Laboratory, contact Dr. Marcelo Vazquez (e-mail: vazquez@bnl.gov), Dr. Betsy Sutherland (e-mail: betsy@image.bio.bnl.gov), or Dr. Phil Pile (e-mail: pile@bnldag.ags.bnl.gov).

Consult this research announcement for instructions on how to incorporate the use of these facilities into a proposal. These instructions **must** be followed in order to access the facilities.

B. Materials Testing Facilities: Facilities Available to Researchers Supporting the NASA Radiation Shielding Materials Development Program

NASA Marshall Space Flight Center (MSFC)
Huntsville, AL 35812

The NASA Marshall Space Flight Center has a wide range of capabilities available to the radiation materials researcher. These capabilities include composite materials fabrication, mechanical and environmental testing, nondestructive testing, polymer thermal analysis and space and environmental effects testing. Points of Contact are listed for each facility and laboratory to provide the researcher with more detail of specific capabilities and/or to arrange for the provision of testing, fabrication, or analysis services.

Composite Materials Fabrication
A wide range of facilities is available for processing of polymers and fiber-reinforced polymer matrix composites. Housed within the National Center for Advanced Manufacturing facility at the Marshall Center, a wide range of equipment is available for materials fabrication.. This equipment includes two CMI automated fiber placement machines, an 18 x 20 ft. and a 9 x 12 ft. autoclave, and a range of presses and ovens. Filament winding capabilities include a polar and a helical winder. Full-service machine shops are available on-site on a contract basis for the fabrication of tooling and miscellaneous hardware. Other related services that are available include manufacturing process development, and adhesives and bonding process development.

POC:
Bruce Hulcher
ED34
Non-Metallic Materials and Process Group
NASA MSFC
Huntsville, AL 35812
256.544.5124
anthony.b.hulcher@nasa.gov

Mechanical and Environmental Testing
A full-service laboratory is available and dedicated to the performance of a wide range of materials testing and evaluations. A total of six mechanical test frames are available for mechanical property testing of materials up to 100K-lbs of load. The lab has the capability to perform mechanical property testing of materials at elevated temperatures, high heat rates and at cryogenic temperatures (LN2, -320ºF). A well-trained staff is available on a contract basis to prepare specimens, perform tests and to collect and reduce data. The staff has experience in

performing a number of different tests, including tension, compression, flatwise tension, adhesive bond strength and lap shear testing.

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Non-Destructive Evaluation
A number of different non-destructive test methods are available within Marshall's Non-Destructive Evaluation Group. These methods include ultrasonics, thermography, shearography, computed tomography, eddy current inspection, radiography, and acoustic emission testing. A staff of engineers, each with dedicated experience in one or more NDE methods, is available for consultation and materials testing and evaluation.

POC:
Michael Suits
ED32
Non-Destructive Evaluation and Tribology Group
NASA MSFC
Huntsville, AL 35812
256.544.8336
mike.suits@nasa.gov

Thermal Analysis for Polymer Characterization
The Thermal Analysis laboratory at MSFC is available for the characterization of thermal, physical and reactive behavior of materials as a function of temperature. Four different instruments are available in the lab to perform the following analyses: differential scanning calorimeter (DSC), thermomechanical analysis (TMA), thermogravimetric analysis (TGA), and dynamic mechanical analysis (DMA). Functions of this lab include material screening and selection, cure characterization of thermosetting polymers, determination of the glass transition temperature and crystalline melt temperature of thermoplastics, material compatibility studies and failure investigations. Low temperature testing may be performed down to –150ºC during DSC, TMA and DMA investigations. Additional capability includes the measurement of the coefficient of thermal expansion of materials. A dedicated technical support staff is available to support research in this area.

POC:
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doug.wingard@nasa.gov

Space and Environmental Effects Testing
http://mpm.msfc.nasa.gov/ED31/index.html
The engineers, physicists, and technicians of the SEE Team evaluate candidate materials by exposing them to laboratory simulations of the space environment, which are complemented by flight experiments whenever possible. The team's simulation capabilities include charged-particle radiation, ultraviolet (UV) radiation, atomic oxygen (AO), plasma, thermal vacuum, and hypervelocity particle impact. The team operates a unique facility for combined environmental effects (CEE) testing. Atomic oxygen, UV radiation, charged particles, plasma, and thermal vacuum may affect the optical, mechanical, and electrical properties of materials. The synergistic effects of these aspects of the space environment are still not completely understood and continue to be investigated. Data from these specialized test systems, combined with analytical results from material flight experiments, enable the SEE Team to determine optimum materials for use on spacecraft.

POC:
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ED31
Environmental Effects Group
NASA MSFC
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miria.finckenor@nasa.gov

Micrometeor and Orbital Debris Testing
Meteoroid and orbital debris impacts are a serious concern for spacecraft in orbit. More than 9,000 objects are being tracked, with millions more particles too small for radar or telescopes to track. These particles travel at hypervelocity speeds, with an average velocity of 10 km/s for orbital debris and up to 60 km/s for micrometeoroids. Micrometeoroids and space debris can puncture manned spacecraft, pit windows and telescope mirrors, and damage solar arrays and thermal radiators. In order to avoid collisions with space debris, spacecraft may be forced to use limited fuel supplies. To quantify the damage caused by debris particles or qualify debris protection systems, MSFC has the micro light gas gun (MLGG). The MLGG is capable of accelerating small particles (0.1–1 mm in diameter) to velocities of 3–9 km/s. The test chamber allows for target samples up to 20 by 20 cm. Projectile velocity is measured with each test using photodiodes attached to an oscilloscope.

POC:
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NASA Langley Research Center (LaRC)
Hampton, VA 23681-1000
http://smc.larc.nasa.gov/
The NASA Langley Research Center's Advanced Materials and Processes Branch has a wide range of materials analysis and characterization laboratories available to the radiation shielding materials development researcher. Capabilities include molecular characterization, thermal analysis, molecular weight characterization, solution characterization, polymer melt rheology, polymer and composite mechanical testing, and electrical and electromechanical characterization. Additionally, a wide range of optical and electron microscopy methods are available for use as well as tools for image analysis.

Thermal Analysis
Thermal analysis and characterization capabilities include differential scanning calorimetry (DSC), thermal mechanical analysis (TMA), thermogravimetric analysis (TGA), differential thermal analysis (DTA) and dynamic mechanical analysis (DMA). Additional capability includes the measurement of the thermal conductivity of materials.

Molecular Characterization
A wide range of instrumentation and testing equipment are available at LaRC for characterization of materials on the molecular level. Test capabilities include Fourier Transform Infrared Spectroscopy (FTIR) in diffuse, transmission attenuated, and specular reflectance modes, UV-Visible-NIR Spectroscopy, Dispersive Raman Spectroscopy, NMR, MALDI-TOF Spectroscopy and HPLC Mass Spectroscopy.

Solution and Molecular Weight Characterization
Solution characterization may be performed including intrinsic viscosity measurements, High-Pressure Liquid Chromatography and Brookfield Viscosity. A number of test methods are available at LaRC for the determination of molecular weights. These include room temperature gel permeation and elevated temperature gel permeation chromatography, low-angle laser light scattering, and differential, membrane, and vapor phase osmometry.

Rheology
A range of rheometers and other instruments are available at LaRC for the study of the melt flow

and viscoelastic behavior of polymeric materials. Langley's facilities include capillary, parallel plate, and rotary rheometers. Brabender twin-screw extruder is also available for polymer melt flow studies.

Microscopy
Numerous instruments are available at Langley for micrographic analysis. These include scanning tunneling, atomic force, and high-resolution scanning electron microscopy. Other capabilities include polarized light transmission microscopy as well as optical microscopy and image analysis tools.

Mechanical Testing for Resins and Composites
Mechanical property testing of composites and resins is available at Langley. A well-trained technical staff is capable of performing a number of property tests including fracture toughness, flexure, film tensile, short beam shear, tensile lap shear and individual fiber tensile and elongation testing.

POC:
Mia Siochi
Advanced Materials and Processes Branch
NASA LaRC
Hampton, VA 23681-1000
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e.j.siochi@nasa.gov

V. Deep Space Test-Bed Facility

NASA is presently developing a Deep Space Test-Bed (DSTB) Facility to conduct radiation-shielding tests in a realistic deep space radiation environment. Earth's magnetic field prevents the full energy spectrum of the Galactic Cosmic Rays (GCR) in interplanetary space from reaching the upper atmosphere except in the Polar Regions. The DSTB approach uses high altitude stratospheric balloons launched at high magnetic latitudes to access the full energy spectrum and composition of the GCRs. These balloons are capable of lifting 1200 kgs of apparatus to altitudes of 3.5millibars (3.5 grams/cm^2 of residual atmosphere). In the past decade such flights have been regularly conducted from Antarctica during the local summer. Flights are launched from McMurdo Station, Antarctica and make a complete circumnavigation of the continent in approximately 20 days providing significant exposure to GCR.

The DSTB is operated as a facility and consists of the gondola, integration laboratory, and support for ground and flight operations. The gondola is designed to carry multiple experiments on each flight. Standard instrumentation is provided by the facility to monitor the radiation environment. The facility also provides supporting subsystems including: solar arrays, power distribution, command and telemetry support, housekeeping, and the mechanical structure.

Resources of power, mass, and telemetry are shared among the individual experiments. Present limitations of these shared resources are: 1200 kgs, 600 watts and 6 kbits/s telemetry rate. How these resources are allocated among the experiments will depend on the requirements of the individual experiments and the composition of the experiment complement. For example, if there are 10 experiments on a flight, the average resources available per experiment are 120 kgs, 60 watts and 600 bits/s telemetry. The final distribution of these resources will depend on the experiment complement chosen for each campaign.

The flow process for each DSTB flight includes selecting the individual experiments to form the experiment complement, configuring the DSTB gondola to accommodate the chosen experiments, integration of the experiments on to the gondola, compatibility testing, field operations, and return of the payload and data to the investigators. One full cycle will span approximately 18 months. The expected schedule for the first polar flight is: selection for the first payload by June 2004, integration in January 2005, and flight operations occurring in December 2005/Januaray 2006. Follow-on flights are planned for on an annual basis and will follow the process flow outlined above.

Additional information relating to the DSTB facility can be found at the website: http://sd.msfc.nasa.gov/cosmicray/dstb/dstb.htm. For technical information relating to the DSTB Facility please contact Mark J. Christl at (256) 961-7739 or mark.j.christl@nasa.gov.

VI. Other Technical Information

For additional information about NASA and its mission and goals, please visit http://www.nasa.gov/. For additional information about the Office of Biological and Physical Research, please visit http://spaceresearch.nasa.gov/.

For information about the shielding consortia contact:

Transport Codes Consortium:
Lawrence W. Townsend, Ph.D.
Robert M. Condra, Professor of Nuclear Engineering
Department of Nuclear Engineering
The University of Tennessee
Knoxville, TN 37996-2300 USA
865.974.5048 (phone)
865.974.0668 (fax)
ltownsen@tennessee.edu

Cross Section Measurements Consortium:
Jack Miller
Lawrence Berkeley National Laboratory
MS 74-197
1 Cyclotron Road
Berkeley, CA 94720
510.486.7130 (phone)
510.486.7934 (fax)
miller@lbl.gov

Application Procedures and Selection Process

Except where specifically stated otherwise in this NRA, applicants must prepare proposals in accordance with the "Instructions for Responding to NASA Research Announcements," which is part of the NASA Federal Acquisition Regulations (FAR) Supplement (NFS), Part 1852.235-72 (Appendix D).

I. Instructions for Notices of Intent and Proposal Submission

A. SYS-EYFUS Registration

SYS-EYFUS is an electronic system used by NASA Headquarters to manage research solicitation activity, plan for the receipt of research proposals, track the receipt and peer evaluation of these proposals, and manage funded research (grants, cooperative agreements, etc.) sponsored by NASA's Office of Equal Opportunity (Code E), Office of Earth Science (Code Y), Office of Human Resources & Education Division (Code F), Office of Biological and Physical Research (Code U), Office of Space Science (Code S), and the Office of Space Flight (Code M). SYS-EYFUS also supports the funding and administration of awards pursuant to selection of these research opportunities.

The SYS-EYFUS Help Desk is available at (202) 479-9376. Help desk hours are from 8 a.m. to 6 p.m. Eastern time.

All investigators planning to submit a proposal to this solicitation are requested to register online with SYS-EYFUS. Comprehensive help, instructions, and contact information are provided online. SYS-EYFUS can be accessed at the following Web address:

http://proposals.hq.nasa.gov/proposal.cfm

If you have previously registered with SYS-EYFUS, you are asked to verify and update your user information. If you have forgotten your user ID or password, select the "Forgot Your Password" option and type in your first and last name to search our database. The system will send an automatic e-mail message with your username and password to the e-mail address listed in our database.

B. Instructions for Preparing a Notice of Intent

All investigators planning to submit a proposal in response to this solicitation are requested to submit a **non-binding** notice of intent (NOI) to propose by the due date identified in the Summary and Supplemental Information Section of this NRA via the Web at the following address:

http://proposals.hq.nasa.gov/proposal.cfm

1) Login to SYS-EYFUS at the URL listed above and select "New Notice of Intent."

2) The Division Specific Opportunities screen will appear. In the selection window, highlight **Bioastronautics Research Division** and click on "Continue."

3) The List of Existing Opportunities screen will appear. In the selection window, highlight **03-OBPR-07** and then click on "Continue."

4) This will bring you to the Notice of Intent Submission Form. **All fields are required.**

   a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.

   b. Please select from **only** the following three options: For the proposal type field on this form, new/no prior support means that the investigator has not received NASA funding from 2000 through 2002, new/prior support means that the investigator has received NASA funding between 2000 through 2002, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2000 through 2002, but not funded. A proposal previously submitted but not funded should be identified as being "revised" even if the original Principal Investigator has changed.

   c. Indicate the status of IRB/IACUC for your proposal. If IRB or IACUC review is unavoidably delayed beyond the submission of the application, enter "Pending" on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.

   d. Provide your TIN and CAGE numbers. Every U.S. institution that submits a proposal to a U.S. agency must provide their permanently-assigned Taxpayer Identification Number (TIN) and must register with the Department of Defense Central Contractor Registration (CCR) database for a permanently-assigned Commercial and Government Entity (CAGE) number. For additional information, reference the 2003 NRA Proposers Guidebook at: http://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2003.pdf

If you are unsure of your institution's TIN number, please contact your institution's Office of Sponsored Research to obtain the your institution's Taxpayer Identification Number (TIN) or Employer Identification Number (EIN).

5) Click on "Submit NOI Page."

6) The Team Member Page screen will appear, where you can add or remove team members. Select continue if there are no other team members. To add a team member, highlight the role option on the selection list, type in first and last name and click on search. When the resulting set appears, choose the appropriate radio button and click on ADD to add the person to the NOI. After you are done, click on "Continue." **IMPORTANT:** If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

7) After continuing from the Team Members Page, your NOI will be displayed. Click on "Resubmit NOI Page" to complete your NOI submission.

8) You may edit and resubmit your NOI at any time before the submission deadline of November 10, 2003. Once you submit an NOI, it cannot be deleted, only edited. For title, team member, or any other changes, please edit your existing NOI and resubmit changes to avoid duplicate records.

C. Instructions for Preparing and Electronically Submitting a Proposal Cover Page

All investigators planning to submit a proposal in response to this solicitation must electronically submit proposal cover page information online and provide a hardcopy of the cover page attached to each proposal copy by the due date indicated in the Summary and Supplemental Information Section of this NRA. The proposal cover page can be submitted and printed via the Web at the following address:

http://proposals.hq.nasa.gov/proposal.cfm

1) Login to SYS-EYFUS at the URL listed above.

2) To submit a New Proposal Cover Page, click the "New Proposal Cover Page" option on the SYS-EYFUS Options screen, and the New Proposals Cover Page screen will appear.

3) If you previously submitted an NOI in response to this solicitation, choose to carry over the existing NOI. This option will populate the cover page fields with the NOI information. Edit the information as necessary, click "Continue," and proceed to #8 below.

4) If you did not previously submit an NOI, click on New Proposal Cover Page option, and the Division Specific Opportunities screen will appear.

5) In the selection window, highlight **Bioastronautics Research Division** and click on "Continue."

6) The List of Existing Opportunities screen will appear. In the selection window, highlight **03-OBPR-07** and then click on "Continue."

7) This will bring you to the Proposal Cover Page Submission Form. Fill in all the fields. All fields are required.

   a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work.Describe concisely (300-500 words) the research design and methods for achieving these aims.

   b. Please select from **only** the following three options: For the proposal type field on this form, new/no prior support means that the investigator has not received NASA funding from 2000 through 2002, new/prior support means that the investigator has received NASA funding between 2000 through 2002, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2000 through 2002, but not funded. A proposal previously submitted but not funded should be identified as being "revised" even if the original Principal Investigator has changed.

   c. Indicate the status of IRB/IACUC for your proposal. If IRB or IACUC review is unavoidably delayed beyond the submission of the application, enter "Pending" on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.

   d. Provide your TIN and CAGE numbers. Every U.S. institution that submits a proposal to a U.S. agency must provide their permanently-assigned Taxpayer Identification Number (TIN) and must register with the Department of Defense Central Contractor Registration (CCR) database for a permanently-assigned Commercial and Government Entity (CAGE) number. For additional information, reference the 2003 NRA Proposers Guidebook at: http://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2003.pdf If you are unsure of your institution's TIN number, please contact your institution's Office of Sponsored Research to obtain the your institution's Taxpayer Identification Number (TIN) or Employer Identification Number (EIN).

Click on "Continue."

8) The Team Member Page screen will appear, where you can add or remove team members. Every proposal must specify the critically important personnel who are expected to play a significant role in the execution of the proposed effort and their institution of employment. Categories of personnel to be included as Team Members are described in Appendix B, Section III, Part D(5) and in Section 1.4.2 in the 2003 NRA Proposers Guidebook (http://www.hq.nasa.gov/office/procurement/nraguidebook/).

   You must include your authorizing official as a team member. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

   IMPORTANT: If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

9) After continuing from the Team Member Page, the Proposal Options Page appears.

10) Please fill out the budget form by clicking on the "Budget" button, filling in project costs, and clicking "Continue." This will bring you to the Proposal Budget Review Page. Click "Continue" if the information is correct.

11) After verifying your budget information, you will be returned to the Proposal Options Page. Click the "Show/Print" button.

12) For detailed budget information, you must use Forms C and D, provided at http://research.hq.nasa.gov/code_u/nra/current/NRA-03-OBPR-07/index.html. Sample copies of Forms C and D are also available in Appendix E. Form D must be filled out for each year of grant support requested. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

13) At the page entitled Proposal Information Item List, click "Continue" to preview your Proposal Cover Page. Print the cover page from your Internet browser once you have reviewed the information. The cover page must be signed by both the Principal Investigator and the authorizing official and attached to the front of your proposal before submission of hard copies to NASA.

   By signing and submitting the proposal identified on the cover sheet, the Authorizing Official of the proposing institution (or the individual investigator if there is no proposing institution): 1) certifies that the statements made in the proposal are true and complete to the best of his/her knowledge; 2) agrees to accept the obligations to comply with NASA Award terms and conditions if an award is made as a result of this proposal; 3) provides certification to the following that are reproduced in their entirety in Appendix D of this NRA: (i) Certification Regarding Debarment,

Suspension and Other Responsibility matters, (ii) Certification Regarding Lobbying, and (iii) Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs.

14) You may edit and resubmit your proposal cover page at any time before the submission deadline as indicated in the Summary and Supplemental Information Section of this NRA. Please note that once you submit a proposal cover page, it can only be edited, not deleted. For title, team member, budget or any other changes, please edit your existing proposal cover page and resubmit changes to avoid duplicate records.

D. Instructions for Preparation and Delivery of Proposals

All proposals submitted must include the completed cover page form as described in this Appendix. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the cover page form, where special places are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of performance may be for any duration up to the maximum duration identified in the Announcement section of this NRA but should be suitable for the project proposed.

The proposal must include the following material, in this order:

(1) Proposal Cover Page: Solicited Proposal Application, including certification of compliance with U.S. code (if applicable). One signed original required. Please see "Instructions for Preparing and Electronically Submitting a Proposal Cover Page" (Appendix B, Section I, Part C) for instructions on how to complete the proposal cover page information.

(2) Transmittal Letter or Prefatory Material, if any (see Appendix D: "Instructions for Responding to NASA Research Announcements" for details).

(3) Proposal Title Page, with Notice of Restriction on Use and Disclosure of Proposal Information, if any (see Appendix D: "Instructions for Responding to NASA Research Announcements," for details)

(4) Project Description

The length of the Project Description section of the proposal cannot exceed 20 pages using regular (12 point) type. Text must be printed on one side only and should have the following margins: left = 1.5"; Right, top, bottom = 1.0".. Referenced figures must be included in the 20 pages of the Project Description. The bibliography and sections (5) through (11) described below are not considered part of the 20-page project description. Proposals that exceed the 20-page limit for the project description (22-page limit for revised proposals; see below) will not be reviewed. The proposal should contain sufficient detail to enable reviewers to make informed judgments

about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with current resources and the resources requested. In addition, the proposal should clearly indicate the relationship between the proposed work and the research emphases defined in this Announcement. Reviewers are not required to consider information presented as appendices or to view and/or consider Web links in their evaluation of the proposal.

New applications where the investigator has received NASA funding in related fields from 2000 through 2002: Results and evidence of progress of the associated NASA supported research must be presented as part of the project description. See "Instructions for Responding to NASA Research Announcements" for details.

Revised applications (revisions of 2000, 2001 or 2002 submissions) must be so designated on the proposal cover page and explained in the project description. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description**, and is in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description. Changes within the proposal may be highlighted by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. **Revised applications that do not address the criticisms in the previous review will be considered non-responsive and will be returned without review.** See "Instructions for Responding to NASA Research Announcements" for additional information.

(5) Management Approach

Each proposal must specify a single Principal Investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

Co-PIs are not permitted with the sole exception when a non-U.S. Co-Investigator is proposed. This exception is described in the Co-Investigator subcategories below.

Investigators are strongly encouraged to identify only the most critically important personnel to aid in the execution of their proposals. Should such positions be necessary, Co-Investigators (CO-Is) may be identified who are critical for the successful completion of research through the contribution of unique expertise and/or capabilities, and who serve under the direction of the PI, regardless of whether or not they receive compensation under the award. Most NRAs require a Co-I to have a well-defined role in the research that is defined in the Management section of the

proposal. Evidence of a Co-I's commitment to participate is often requested through a brief letter to be included with the proposal.

There are three subcategories of Co-Is that a proposal may identify, as appropriate:

- A Co-I may be designated as the ***Science PI*** for those cases where the proposing institution does not permit that individual to formally serve as the PI as defined above. In such a case, the Science PI will be understood by NASA to be in charge of the scientific direction of the proposed work, although the formally designated PI is still held responsible for the overall direction of the effort and use of funds.

- A Co-I may be designated as an ***Institutional PI*** when their institution is making a major contribution to a proposal submitted by a PI from another institution.

- A Co-I from a non-U.S. institution may be designated as a ***Co-Principal Investigator*** (Co-PI) should such a designation serve required administrative purposes of the Co-I's institution and/or for the procurement of funding by that Co-I from their institution.

Additional category positions are often included in proposals as defined as follows:

A ***Postdoctoral Associate*** holds a Ph.D. or equivalent degree and is identified as a major participant in the execution of the proposed research. Such personnel may be identified by name or only by function in those cases where their recruitment depends on the successful selection of the proposal.

Other Professional is a description appropriate for personnel who support a proposal in a critical albeit intermittent manner, such as a consulting staff scientist or a key Project Engineer and/or Manager, who is not identified as a Co-I or Postdoctoral Associate.

A ***Graduate Student*** included in a proposal is working for a post-graduate degree and will support the proposed research under direction of the PI. Such a student may be identified by name or only by function in case their recruitment depends on the successful selection of the proposal.

A ***Collaborator*** is an unfunded position included in a proposal, whose participation is less critical than a Co-I, but who is committed to provide a specific contribution to the proposal

(6) Personnel/Biographical Sketches

The biographical sketch for each investigator should not exceed two pages. If the list of qualifications and publications exceeds two pages, select the most pertinent

information (see "Instructions for Responding to NASA Research Announcements" for details). You must use the biographical sketch form (Form B, Appendix E).

(7) Facilities and Equipment (see "Instructions for Responding to NASA Research Announcements" for details)

(8) Special Matters (specific information on animal or human subjects protocol approval required, if applicable)

For proposals employing human subjects and/or animals, assurance of compliance with human subjects and/or animal care and use provisions is required on the Proposal Cover Page. In addition, the application must include a statement from the applicant institution certifying that the proposed work will meet all Federal and local human subjects requirements and/or animal care and use requirements.

Policies for the protection of human subjects in NASA sponsored research projects are described in NASA Management Instruction (NMI) 7100.8B (*Protection of Human Research Subjects*). Animal use and care requirements are described in the NASA Code of Federal Regulations (CFR) 1232 (*Care and Use of Animals in the Conduct of NASA Activities*). Both documents are available from the Office of Biological and Physical Research, Code UB, NASA Headquarters, Washington, DC 20546.

Additional Requirements for Research Employing Human Subjects

A letter signed by the Chair of the Institutional Review Board (IRB) identifying the proposal submitted to NASA by title and certifying approval of proposed human subjects protocols and procedures should be included with each copy of the proposal. IRB certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IRB certification is pending on the proposal due date, select "pending" from the IRB/IACUC section menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IRB Chair identifying the proposal by title and indicating the status of the IRB review process at the time of submission. IRB certification must be received no later than 90 days after the proposal due date. An application lacking the required IRB certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

With regard to research involving human subjects, NASA and the NSBRI have adopted the National Institutes of Health (NIH) policy. Women and members of minority groups and their subpopulations must be included in NASA-supported biomedical and behavioral research projects involving human subjects, unless a clear

and compelling rationale and justification is provided showing that inclusion of these groups is inappropriate with respect to the health of the subjects or the purpose of the research.

NASA will require current IRB certification prior to each year's award.

Additional Requirements for Research Employing Animals

Specific information describing and justifying the use of animal subjects must be included in the proposal.

A letter signed by the Chair of the Institutional Animal Care and Use Committee (IACUC) identifying the proposal submitted to NASA by title and certifying approval of the proposed animal research protocols and procedures should be included with each copy of the proposal. The institution's Public Health Service Animal Welfare Assurance Number must be included on the IACUC certification and entered in the IRB/IACUC section of the Proposal Cover Page. IACUC certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IACUC certification is pending on the proposal due date, select "pending" from the IRB/IACUC selection menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IACUC Chair identifying the proposal by title and indicating the status of the IACUC review process at the time of submission. IACUC certification must be received no later than 90 days after the proposal due date. An application lacking the required IACUC certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

NASA will require current IACUC certification prior to each year's award.

(9) Detailed Budget and Supporting Budgetary Information (Appendix E, Forms C and D)

For detailed budget information, you must use Forms C and D provided in Appendix E. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

NASA is expected to be operating on the basis of full cost accounting as soon as possible, including all Civil Service salaries with overhead. In the interim period, proposals should use the accounting method authorized at their institutions at the time proposals are due and for the entire proposed period of performance. Funds to support the Resident Research Assistant (RRA) Postdoctoral Program costs (e.g., stipend, travel, computer time, supplies, etc.) are to be budgeted within the NASA intramural Principal Investigator budget.

If travel is planned, the proposal budget should include appropriate travel funds for visits to NASA field centers (as appropriate) and presentation of findings at professional society meetings.

In this solicitation, the terms "cost" and "budget" are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: $1,000, or Labor: $6,000) may cause delays in evaluation and award. Generally, costs will be evaluated for realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate, such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations.

Other Direct Costs

Please detail, explain, and substantiate other significant cost categories as described below:

- Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
- Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay.
- Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General-purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested as a direct charge must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
- Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
- Travel: Describe the purpose of the proposed travel in relation to the grant, and provide the basis of estimate, including information on destination and number of travelers (if known).

- Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts. All awards made as a result of this NRA maybe funded as grants or contracts. However, while proposals submitted by "for profit" organizations are allowed, they cannot include a "fee."

(10) Other Support: You must complete Form E, Appendix E, for specific sources of other support for the principal investigator and each Co-Investigator (not consultants).

(11) Appendices, if any (**reviewers are not required to consider information presented in appendices**).

(12) One (1) signed original and twenty (20) copies of the proposal cover page and the proposals must be received by **4:30 p.m., January 9, 2004**, at the following address:

NASA Peer Review Services
SUBJECT: 03-OBPR-07 Space Radiation Research
500 E Street SW
Suite 200
Washington, DC 20024
(202) 479-9030

II. Proposal Evaluation and Awards Selection Process

The following information is specific to this NRA and **supersedes** the information contained in paragraphs (i) and (j) of Appendix D, "Instructions for Responding to NASA Research Announcements."

A. Compliance Matrix

All proposals must comply with the general requirements of the Announcement as described in both Appendices B and Appendix D, "Instructions for Responding to NASA Research Announcements." Appendix B contains specific requirements and explanations for each section of the proposal above and beyond NASA-specified requirements. Appendix D, "Instructions for

Responding to NASA Research Announcements," outlines the NASA-specified requirements for proposal submission and should be used for clarification and reference. Upon receipt, proposals will be reviewed for compliance with the requirements of this Announcement. This includes

1. Submission of complete proposals specified in this Announcement. Proposals must be responsive to the areas of program element emphasis described in this Announcement and include a project description that is not more than 20 pages in length.
2. Submission of appropriate Institutional Review Board (IRB) or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects.
3. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding that described in the Announcement.
4. Proposals that are revised versions of proposals previously submitted to NASA must be clearly designated as such on the proposal cover page and must contain an explanation of how the revised proposal has addressed criticisms from previous NASA review. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description** and is in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description.
5. Submission of all other appropriate information as required by this NASA Research Announcement (refer to Section I, Appendix B).

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the investigator without further review.

Compliant proposals submitted in response to this Announcement will undergo an intrinsic scientific or technical merit review. Only those proposals most highly rated in the merit review process will undergo additional reviews for program relevance and cost.

B. Intrinsic Scientific or Technical Merit Review and Evaluation Criteria

The **first review tier** will be a merit review by a panel of scientific or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in Appendix A. The merit review panel will assign ***a score from 0-100*** based upon the intrinsic scientific or technical merit of the proposal. This score will reflect the consensus of the panel.

The score assigned by this panel ***will not be affected by the cost of the proposed work nor will it reflect the programmatic relevance of the proposed work to NASA***.. However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the proposal's budget and relevance to NASA.

All of the following criteria will be used in determining the merit score (approach is the most important; investigation is given more weight than significance, innovation, and environment):

- **Significance:** Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field? Is there a significant societal or economic impact?
- **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics?
- **Innovation:** Does the project employ appropriate novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
- **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
- **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

C. Evaluation of Programmatic Relevance and Cost

The **second review** will evaluate the programmatic relevance and cost of all proposed work. NASA Program Scientists and Managers will conduct this review. Evaluation of the cost of a proposed effort includes consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds. Programmatic relevance will include an evaluation of how the proposed work may help achieve an appropriate balance of scientific and technical tasks required by critical research issues faced by NASA and OBPR.

D. Development of Selection Recommendation

The most important element in the evaluation process is the merit review, which carries the highest weight in final evaluation and selection. The other factors are approximately equal in weight to each other.

The information resulting from these two levels of review, as described above, will be used to prepare a **selection recommendation** developed by NASA program scientists and managers for each of the program elements described in this Announcement. This recommendation will be based on:

1. The scientific or technical merit review score from the peer review panel.
2. The programmatic relevance.
3. The cost of each proposal.

This **selection recommendation** is the responsibility of the NASA program scientist(s). Selection for funding will be made by the Selection Official identified in the Summary and Supplemental Information Section of this NRA.

At the end of the selection process, each proposing organization is notified of its selection or nonselection status. NASA provides debriefings to those investigators who request one. The selection letters will include a statement indicating the selected organization's business office will be contacted by a NASA Contracting or Grant Officer, who is the only official authorized to obligate the Government, and a reminder that any costs incurred by the investigator in anticipation of an award are at their own risk. Selection notification will be made by a letter signed by the selection official.

The NASA Procurement Office will determine the type of award instrument, request further business data, negotiate the resultant action, and are the only personnel with the authority to obligate government funds.

NASA reserves the right to offer selection of only a portion of a proposal. In these instances, the investigator will be given the opportunity to accept or decline the offer.

III. Eligibility

All categories of institutions are eligible to submit proposals in response to this NRA, but only approved proposals from U.S. institutions will be selected for funding. Principal Investigators may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in science and technology or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior support by NASA of research or training in any institution or for any investigator is neither a prerequisite to submission of a proposal nor a competing factor in the selection process.

IV. Guidelines for International Participation

Guidelines for International Participation are detailed in paragraph l of Appendix D of this Announcement**.**

Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation. Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign

participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective investigator to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at http://www.pmdtc.org/ and http://www.bxa.doc.gov/. Investigators are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and are subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

V. Program Reporting

It is expected that results from funded research will be submitted to peer-reviewed journals as the work progresses. Published papers must acknowledge NASA's support and identify the grant or contract. Published papers resulting from the research project will be used to evaluate productivity and eligibility for continued funding.

Annual Reporting. The Office of Biological and Physical Research publishes a comprehensive annual document titled OBPR Program Tasks and Bibliography (Task Book) which includes descriptions of all peer-reviewed activities funded by the division during the previous fiscal year. Since its inception, the Task Book has served as an invaluable source of information for OBPR as well as the scientific and technical communities.

Investigators are required to provide NASA with this annual summary information. This information will be made available to the scientific community and will be used to assess the strength of the Division's programs. It will also serve as the basis for determining the degree of progress of the project. The information provided for the Task Book will meet the annual reporting requirements. This report will be due 60 days prior to the anniversary date of the grant start date.

The information requested will include:

- an abstract
- a brief statement of progress during the fiscal year
- a brief statement of benefits of the research with respect to life on Earth
- a bibliographic list for the fiscal year
- a copy or reprint of each publication listed in the bibliography for the fiscal year
- a listing of presentations or activities conducted at 6-12 educational institutions
- a listing of interactions, presentations, or other activities with the general public
- copies of publications
- a statement of progress
- potential scientific, technological, economic or societal impact

Note that although this publication will be made available to the general scientific community, it is not a substitute for traditional scientific reporting in journals and elsewhere.

All articles submitted for publication must include the following statement: "This research was funded in whole or in part by a grant from the Office of Biological and Physical Research of the National Aeronautics and Space Administration." Publications not including this acknowledgement will not be considered to be the product of NASA-funded research when NASA assesses the progress of the grant.

Final Report: A final report is required that shall include all peer-reviewed publications.

VI. Support of Education and Public Outreach

OBPR envisions that the selected proposals will be structured and operated in a manner that supports the nation's educational initiatives and goals (including support of historically black colleges and universities and other minority universities), and in particular the need to promote scientific and technical education at all levels. OBPR envisions that the selected proposals will support the goals for public awareness and outreach to the general public (see Announcement Section). The selected principal investigators are invited to participate in OBPR-funded educational programs.

OBPR Policy for Education (Grades 6-12) and Public Outreach

The proposal represents an opportunity for NASA to enhance and broaden the public's understanding and appreciation of the value of OBPR research in the context of NASA's mission. Therefore, all investigators are strongly encouraged to promote general scientific literacy and public understanding of OBPR research through formal and/or informal education opportunities. If appropriate, proposals should include a clear and concise description of the education and outreach activities proposed. Examples include such items as involvement of students in research activities, technology transfer plans, public information programs that will inform the general public of the benefits being gained from the research, and/or plans for incorporation of scientific results obtained into educational curricula consistent with educational standards.

Where appropriate, the supported institution will be required to produce, in collaboration with NASA, a plan for communicating to the public the value and importance of their work.
Once NRA selections are made, the selected PIs will have an opportunity to request additional funding through an OBPR-sponsored pilot program to implement an education outreach program at the grades 6-12 level, at an amount not to exceed $10,000 per year for the term of the grant. A request for proposal will accompany the selection notification letter. Proposals will be due within 60 days of selection notification and shall be limited to 4 pages. A review of these proposals by educational specialists will determine which proposals will be funded.

VII. References

A. General References

Guidebook For Proposers Responding To A NASA Research Announcement (NRA) is available online at the following address:
http://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2003.pdf

OBPR Program Tasks and Bibliography (Task Book) for **FY 1995 through FY 2002** are available online at the following address:
http://research.hq.nasa.gov/taskbook.cfm

Space Life Sciences Ground Facilities Information Package. This document is available online at the following address:
http://research.hq.nasa.gov/code_u/nra/current/NRA-03-OBPR-03/index.html

Life sciences research publications: http://spaceline.usuhs.mil/**,** and http://www.nlm.nih.gov/**.** Additional information may be obtained from the SPACELINE Project (phone: (301) 295-2482; e-mail: spaceline@usuhs.mil).

National Academy of Science. National Research Council Committee on Space Biology and Medicine. Mary J. Osborn, Committee Chairperson. **A Strategy for Research in Space Biology and Medicine in the New Century.** 1998. Washington D.C: National Academy Press. Web address: http://www.nas.edu/ssb/csbm1.html

A. Nicogossian, C. Huntoon, and S. Pool. (Eds.) **Space Physiology and Medicine, 3rd ed**. Lea & Febiger. Philadelphia, PA (1994).

FASEB Journal, Vol. 13, Supplement, **Cell & Molecular Biology Research in Space**. (1999).
Brain Research Reviews, **Space Neuroscience Research**. Volume 28, Numbers 1/2, Special Issue, (1998).

NASA Space Radiation Health Program Strategic Plan:
http://spaceresearch.nasa.gov/docs/radiation_strat_plan_1998.pdf

Space Radiation Health Project at Johnson Space Center: http://srhp.jsc.nasa.gov/

B. Selected Radiation References

Alpen, E.L., Powers-Risius, P., Curtis, S.B., and DeGuzman, R. Tumorigenic potential of high-Z, high-LET charged particle irradiations. Radiat. Res. 88, 132-143 (1993).

Blakely, E.A., Bjornstad, K.A., Chang, P.Y., McNamara, M.P., Chang, E., Aragon, G., Lin, S.P., Lui, G., and Polansky, J.R. Growth and differentiation of human lens epithelial cells in vitro on matrix. Inv. Opth. & Vis. Sci. 41, 3898-3907 (1999).

Cucinotta, F. A., W. Schimmerling, J. W. Wilson, L. E. Peterson, G. Badhwar, P. Saganti, and J. Dicello. Space Radiation Cancer Risks and Uncertainties for Mars Missions. Radiat. Res. 156: (2001)156, 682–688.

Cucinotta, F. A., F.K. Manuel, J. Jones, G. Iszard, J. Murrey, B. Djojonegro, and M. Wear. Space Radiation and Cataracts in Astronauts. Radiat. Res. 156: 460-466 (2001).

Cucinotta, F.A., Nikjoo, H., and Goodhead, D.T. The effects of delta rays on the number of particle-track traversals per cell in laboratory and space exposures. Radiat. Res. 150, 115-119 (1998).

Cucinotta, F.A., Wilson, J.W., Williams, J.R., and Dicello, J.F. Analysis of Mir-18 results for physical and biological dosimetry: radiation shielding effectiveness in *LEO. Radiat. Meas*. **31,** 181-191 (2000).

Ernhart, E.J., E.L. Gillette, E.L., and Barcellos-Hoff, M.H. Immunohistochemical evidence for rapid extracellular matrix remodeling after iron-particle irradiation of mouse mammary gland. Radiat. Res. 145, 157-162 (1996).

Fry R.J.M., Powers-Risius P., Alpen E.L., Ainsworth, E.J. High LET radiation carcinogenesis. Radiat. Res. 104, S188-195 (1985).

Goodhead, D.T. Initial events in the cellular effects of ionizing radiations: clustered damage in DNA. *Int. J. Radiat. Biol.* **65**, 7-17 (1994).

Joseph, J.A., Hunt, W.A., Rabin, B.M., Dalton, T.K. Possible accelerated aging induced by 56Fe heavy particle irradiation: Implications for manned space flights. Radiat. Res. 130, 88-93 (1992).

National Council on Radiation Protection and Measurements (NCRP). Guidance on Radiation Received in Space Activities. Report 98. Washington, DC (1989)

National Council on Radiation Protection and Measurements (NCRP). Uncertainties in Fatal Cancer risk Estimates Used in Radiation Protection. Report 126. Washington, DC (2000)

National Council on Radiation Protection and Measurements (NCRP). Radiation Protection Guidance for Activities in Low-Earth Orbit. Report 132. Washington, DC (2000).

National Research Council. Radiation Hazards to Crews of Interplanetary Missions: Biological Issues and Research Strategies. National Academy Press, Washington, DC (1996)

National Research Council. Radiation and the International Space Station. National Academy Press, Washington, DC (2000).

Schimmerling, W. Space and radiation protection: scientific requirements for space research. Radiat. Environ. Biophys. 34: 133-137 (1995).

Shimizu, Y., Pierce, D.A., Preston, D.L., and Mabuchi, K. (1999): Studies of the mortality of atomic bomb survivors. Report 12, Part II. No cancer mortality: 1950-1990. Radiation Research 152, 374-389.

Zeitlin, C., J. Miller, L. Heilbronn, K. Frankel, W. Gong and W. Schimmerling, The Fragmentation of 510 MeV/Nucleon Iron-56 in Polyethylene. I. Fragment Fluence Spectra. Radiat. Res. 145: 655-665 (1996).

Zeitlin, C., L. Heilbronn, J. Miller W. Schimmerling, L. W. Townsend, R.K. Tripathi, and J. Wilson The Fragmentation of 510 MeV/Nucleon Iron-56 in Polyethylene. II. Comparisons between Data and a Model. Radiat. Res. 145: 666-672 (1996).

C. Selected Workshop Reports

Modeling Human Risk: Cell & Molecular Biology in Context. June, 1997. Ernest Orlando Lawrence Berkeley National Laboratory Report LBNL-40278. Berkeley, CA

International Space Life Sciences Working Group on Radiation Biology. Banff, Canada, November 1997. Mutation Res., 430: No. 2 (1999)

Models for Evaluation of Radiation Risk Factors. Radiat. Res. 156: Number 5, Part 2. November, 2001.

Second International Workshop on Space Radiation Research and13th Annual NASA Space Radiation Health Investigators' Workshop, March 10-15, 2002, Nara, Japan: http://www.nirs.go.jp/usr/workshop/index.htm

D. Selected Radiation Web Sites

Loma Linda University/NASA Radiobiology Program: http://www.llu.edu/llu/ci/nasa/

NASA activities at Brookhaven National Laboratory: http://www.bnl.gov/medical/NASA/NASA-home frame.htm

NASA Specialized Center of Research and Training at Lawrence Berkeley Laboratory: http://www.lbl.gov/lifesciences/NSCORT/

APPENDIX C
NRA 03-OBPR-07

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1269.

A. The applicant certifies that it and its principals:

(a) are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification; and

(d) have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.

b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

CERTIFICATION REGARDING LOBBYING

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, an or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

CERTIFICATION OF COMPLIANCE WITH THE NASA REGULATIONS PURSUANT TO NONDISCRIMINATION IN FEDERALLY ASSISTED PROGRAMS

The (Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant") hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1962 (20 U.S. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S. 794), and the Age Discrimination Act of 1975 (42 U.S. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participating in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and the United States shall have the right to seek judicial enforcement of this assurance. His assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

(MAY 2002)

(a) **General.**

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate award instrument. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b) **NRA-Specific Items.** Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c) The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) **Transmittal Letter or Prefatory Material.**

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) **Restriction on Use and Disclosure of Proposal Information.** Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) **Abstract.** Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) **Project Description.**

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) **Management Approach.** For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) **Personnel.** The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity.

Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) **Facilities and Equipment.**

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) **Proposed Costs (U.S. Proposals Only).**

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(iv) Use of NASA funds--NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted. Additionally, in accordance with the National Space Transportation Policy, use of a non-U.S. manufactured launch vehicle is permitted only on a no-exchange-of-funds basis.

(9) **Security.** Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) **Current Support.** For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) **Special Matters.**

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

(d) **Renewal Proposals.**

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e) **Length.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f) **Joint Proposals.**

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g) **Late Proposals.** Proposals or proposal modifications received after the latest date specified for receipt may be considered if a significant reduction in cost to the Government is probable or if there are significant technical advantages, as compared with proposals previously received.

(h) **Withdrawal.** Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i) **Evaluation Factors.**

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j) **Evaluation Techniques.** Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by

a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review may be included in subsequent reviews unless the proposer requests otherwise.

(k) **Selection for Award.**

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(l) **Additional Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.**

(1) NASA welcomes proposals from outside the U.S. However, foreign entities are generally not eligible for funding from NASA. Therefore, unless otherwise noted in the NRA, proposals from foreign entities should not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan for only the participation of the U.S. entity must be included. Proposals from foreign entities and proposals from U.S. entities that include foreign participation must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA, and if the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

(2) All foreign proposals must be typewritten in English and comply with all other submission requirements stated in the NRA. All foreign proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be received before the established closing date. Those received after the closing date will be treated in accordance with paragraph (g) of this provision. Sponsoring foreign government agencies or funding institutions may, in exceptional situations, forward a proposal without endorsement if endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

(3) Successful and unsuccessful foreign entities will be contacted directly by the NASA sponsoring office. Copies of these letters will be sent to the foreign sponsor. Should a foreign proposal or a U.S. proposal with foreign participation be selected, NASA's Office of External Relations will arrange with the foreign sponsor for the

proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency or funding institution will each bear the cost of discharging their respective responsibilities.

(4) Depending on the nature and extent of the proposed cooperation, these arrangements may entail:

(i) An exchange of letters between NASA and the foreign sponsor**;** or

(ii) A formal Agency-to-Agency Memorandum of Understanding (MOU).

(m) **Cancellation of NRA.** NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

APPENDIX E
NRA 03-OBPR-07

Proposal Submission Frequently Asked Questions (FAQs) And Required Forms

The information provided here is in response to questions from investigators such as yourself. Additional information regarding submission procedures and requirements can be found in the research announcement to which you are responding, and at the NASA online proposal site:

http://proposals.hq.nasa.gov/proposal.cfm

1. What forms should I use when submitting a proposal?
Currently, the NASA proposal site does not support the uploading of information or forms other than the information gathered while completing the online cover page. Please complete the online cover page early in the process (you can always return and edit the cover page at any time up to the due date). After completing the cover page, any additional information you are required to provide must be submitted in hardcopy using the forms in this appendix. A standard checklist of materials to include is also provided. Information outside of the online proposal cover page and the required forms in this document can be provided in any format you choose, as long as it adheres to the NRA requirements. Please reference the NRA for information on all material required when submitting your proposal. Please be aware that we ask for copies of the completed proposal package, not just the project description, and must **receive** the copies by the proposal due date. The additional information requested in the NRA does not count towards the 20-page limit of your project description.

2. Where does my authorizing official sign?
You must include your authorizing official as a team member. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

To be added as a team member to your proposal, the individual must be registered with the SYS-EYFUS system. If you try and add a team member and they are not found in the database, you must contact and have that individual register as a new SYS-EYFUS user. You will then be able to add them as a team member.

3. Who should I contact if I receive errors or have additional problems while using the NASA proposal site?
For technical support, please e-mail proposals@hq.nasa.gov or call 202-479-9376 (Monday to Friday 8 a.m.-6 p.m. EST/EDT).

CHECKLIST FOR PROPOSERS

- ☐ Proposal Cover Page (completed online, hardcopy included with proposal)
- ☐ Response to previous reviews (if applicable)
- ☐ Project Description
- ☐ Biographical Sketches
- ☐ Other Support
- ☐ Facilities and Equipment Description
- ☐ Summary Budget Form/Budget Justification
- ☐ Detailed 12-Month Budget (for each year of support)
- ☐ IRB or ACUC letter/form (if applicable)
- ☐ Letters of Collaboration/Support (if applicable)
- ☐ Appendices, if any

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel.
Photocopy this page or follow this format for each person.

NAME	POSITION TITLE

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training).

INSTITUTION(S) AND LOCATION	DEGREE(S) (if applicable)	YEAR(S)	FIELD(S) OF STUDY

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years, and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. **DO NOT EXCEED TWO PAGES.**

Form C

BUDGET FOR ENTIRE PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS		***1st BUDGET PERIOD***	***ADDITIONAL YEARS OF SUPPORT REQUESTED***		
			2nd	**3rd**	**4th**
PERSONNEL (Salary and Fringe Benefits) (Applicant organization only)					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT					
SUPPLIES					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES					
TOTAL DIRECT COSTS FOR EACH PERIOD					
TOTAL INDIRECT COSTS FOR EACH PERIOD					
TOTAL DIRECT + INDIRECT COSTS FOR EACH PERIOD					
TOTAL DIRECT + INDIRECT COSTS FOR ENTIRE PROJECT					

Form D

JUSTIFICATION FOR UNUSUAL EXPENSES:

DETAILED BUDGET FOR 12-MONTH BUDGET PERIOD **DIRECT COSTS ONLY** Duplicate this form for each year of grant support requested		FROM		THROUGH	
PERSONNEL (Applicant Organization Only)		FUNDING AMOUNT REQUESTED			
NAME	**ROLE IN PROJECT**	**EFFORT ON PROJECT**	SALARY	**FRINGE BENEFITS**	**TOTALS**
	Principal Investigator				
SUBTOTALS →					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT (Itemize; use additional sheet if needed)					
SUPPLIES (Itemize by category; use additional sheet if needed)					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES (Itemize by category; use additional sheet if needed)					
TOTAL DIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
INDIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
TOTAL COST FOR FIRST 12-MONTH BUDGET PERIOD					

OTHER SUPPORT

Please provide information regarding specific sources of other support for the principal investigator and each co-investigator (not consultants). This information should be provided separately for each individual in the format shown below. List all active support for an individual before listing pending support. Include the investigator's name at the top of each page and number pages consecutively.

NAME OF INDIVIDUAL		
ACTIVE/PENDING		
Project Number (Principal Investigator)	Dates of Approved/ Proposed Project	Percent Effort
Source	Annual Direct Costs	
Title of Project (or Subproject)		
One-sentence description of project goals. (The major goals of this project are…)		
Brief description of potential scientific or commitment overlap with respect to this individual between this application and projects described above (summarized for each individual).		

CRITICAL PATH ROADMAP (CPR) FORM

Hypotheses	**Risk Number** (from Critical Path Roadmap)	**Critical Question Number** (from Critical Path Roadmap)	**Critical Question** (from Critical Path Roadmap)	**Specific Aim**